STATIC DEFORMATION OF TWO HALF SPACES IN SMOOTH CONTACT DUE TO VERTICAL TENSILE FAULT

Mahabir Singh[#1], Meenal Malik[#2] and Jagdish Singh[#3]
#1 Deenbandhu Chhotu Ram University of Science and Technology, Murthal, Sonepat-139031
#3 Department of Mathematics, Maharshi Dayanand University, Rohtak-124001
#2Department of Applied Sciences, Matu Ram Institute of Engineering and Management, Rohtak-124001
[1]msdhankhar@gamil.com
[3]js_nandal_2K5@yahoo.com
[2]meenaljalaj@gmail.com

I. ABSTRACT

Closed-form analytic expressions for the Airy stress function, stresses and displacements for half-spaces in smooth contact by applying suitable boundary conditions at the interface are first obtained. These expressions are then integrated analytically to derive the Airy stress function for a vertical tensile fault of arbitrary dip and finite width. Closed-form analytical expressions for the displacements and stresses follow immediately from the Airy stress function. The variation of the stresses with the horizontal distance from the fault and with the depth studied numerically. The results obtained in smooth contact are compared with that of welded contact.

KEYWORDS Deformation, Dyke injection, Vertical tensile fault, Smooth contact, Welded contact

II. INTRODUCTION

Rongved (1955) obtained closed-form algebraic expressions for the Neuber-Papkovich displacement potentials for an arbitrary point force acting in an infinite medium consisting of two elastic half-spaces in welded contact. Dundurs and Hetenyi (1965) obtained these functions when the half-spaces are in smooth contact and also obtained the corresponding displacement field. Moreover, they compared the traction for a smooth interface with that for a perfect bond between the two semi-infinite solids. Heaton and Heaton (1989) used the expressions for the Neuber-Papkovich functions derived by Rongved (1955) to obtain analytical expressions for the static deformation field produced by point forces and point force couples embedded in two Poissonian half-spaces in welded contact. Kumari et al. (1992) generalized the results of Heaton and Heaton (1989) and they obtained the expressions for the displacements for arbitrary Poisson's ratio. Furthermore, they obtained closed-form analytical expression for the stresses as well. Sharma et al. (1991) obtained closed-form analytical expressions for the displacement and stresses at any point of either of the two homogeneous, isotropic, perfectly elastic half-spaces in welded contact due to very long strike-slip dislocations.

Singh and Garg (1986) obtained the integral expression for the Airy stress function in an unbounded medium due to various two-dimensional seismic sources. Beginning with these expressions, Rani et al. (1991) obtained the integral expressions and hence closed form analytical expressions for the Airy stress function, displacements and stresses in a homogeneous, isotropic, perfectly elastic half-space due to various two-dimensional sources by applying the traction-free boundary conditions at the surface of the half-space. Singh and Rani (1991) obtained closed-form analytical expressions for the displacements and stresses at any point of a two-phase medium consisting of a homogeneous, isotropic, perfectly elastic half-space in welded contact with a homogeneous, orthotropic, perfectly elastic half-space caused by two-dimensional seismic sources located in the isotropic half-space.Singh et al. (1992) followed a similar procedure to obtain the closed-form analytical expression for the displacements and stresses at any point of either of two homogeneous, isotropic, perfectly elastic half-spaces in welded contact due to two-dimensional sources.

Singh and Singh (2000) derived closed–form analytical expressions for the displacements and stresses at an arbitrary point of the half-space caused by a long vertical tensile fault of finite width. Singh et al. (2002) extended the results of Singh (2000) and obtained the closed-form analytical expression for the subsurface stresses and displacements caused by a long inclined tensile fault buried in a homogeneous isotropic half-space. The effect of depth of the upper edge of the fault and the dip angle on the deformation field has been examined. Kumar et al. (2005) derived analytical expressions for the displacements and stress fields at any point of the two homogeneous, isotropic elastic half-spaces in welded contact caused by a long tensile fault of arbitrary dip and finite width.

In this paper, we obtain closed-form analytical expressions for the displacements and the stresses at any point of either of the two homogeneous, isotropic, perfectly elastic half-spaces in smooth contact caused by various two-dimensional sources embedded in one of the half-spaces. The results are valid for arbitrary Poisson's ratio. Only plane strain case is considered. The stresses for the smooth interface case are compared with the corresponding stresses for the welded interface.

We begin with the integral expressions for the Airy stress function in an unbounded medium given by Singh and Garg (1986) to obtain the integral expressions for the Airy stress functions stresses and displacements for the two half-spaces in smooth contact by applying suitable boundary conditions at the interface. The integrals are then evaluated analytically, obtaining closed-form expressions for the stresses at any point of either of the two half-spaces caused by vertical tensile fault. For numerical calculations, half spaces are assumed Poissionian.

III. THEORY

Let the Cartesian coordinates be denoted by (x_1, x_2, x_3) with x_3-axis vertically downwards. Consider a two-dimensional approximation in which the displacement components u_1, u_2, u_3 are independent of x_1 so that $\partial/\partial x_1 \equiv 0$. Under this assumption, the plain strain problem $(u_1 = 0)$ can be solved in terms of the Airy stress function U such that

$$\tau_{22} = \frac{\partial^2 U}{\partial x_3^2}, \quad \tau_{33} = \frac{\partial^2 U}{\partial x_2^2}, \quad \tau_{23} = -\frac{\partial^2 U}{\partial x_2 \partial x_3}, \tag{1}$$

$$\nabla^2 \nabla^2 U = 0 \tag{2}$$

where τ_{ij} are the components of stress and $\nabla^2 \equiv \frac{\partial^2}{\partial x_2^2} + \frac{\partial^2 U}{\partial x_3^2}$.

We have (Sokolnikoff,1956,Sec.71)

$$\left.\begin{aligned} 2\mu u_2 &= -\frac{\partial U}{\partial x_2} + \frac{1}{2\alpha}\int \nabla^2 U \, dx_2, \\ 2\mu u_3 &= -\frac{\partial U}{\partial x_3} + \frac{1}{2\alpha}\int \nabla^2 U \, dx_3, \end{aligned}\right\} \tag{3}$$

where $\alpha = \frac{(\lambda+\mu)}{(\lambda+2\mu)} = \frac{1}{2(1-\sigma)}$.

We consider two homogeneous, isotropic, perfectly elastic half-spaces which are in smooth contact along the plane $x_3 = 0$. The upper half-space $(x_3 < 0)$ is called medium I and the lower half-space $(x_3 > 0)$, medium II, with elastic constants λ_1, μ_1 and λ_2, μ_2 respectively (Figure 1). The superscript (1) denotes the quantities related to medium I and the superscript (2) denotes those related to medium II.

Let there be line source parallel to x_1-axis. As shown by Singh and Garg (1986), the Airy stress function U_0 for a line source parallel to the x_1 axis passing through the point $(0,0,h)$ in an infinite medium can be expressed in the form

$$\begin{aligned} U_0 = \int_0^\infty &\left[\left(L_0 + M_0 k|x_3 - h|\right)\sin kx_2\right. \\ &\left.+\left(P_0 + Q_0 k|x_3 - h|\right)\cos kx_2\right] k^{-1} e^{-k|x_3 - h|} dk, \end{aligned} \tag{4}$$

where the source coefficients L_0, M_0, P_0 and Q_0 are independent of the variable k. For a line source parallel to the x_1 axis passing through the point $(0,0,h)$ of medium II, the expression for the Airy stress functions in the two half-spaces are of the form

$$\begin{aligned} U^{(1)} = \int_0^\infty &\left[\left(L_1 + M_1 kx_3\right)\sin kx_2\right. \\ &\left.+\left(P_1 + Q_1 kx_3\right)\cos kx_2\right] k^{-1} e^{kx_3} dk, \end{aligned} \tag{5}$$

$$U^{(2)} = U_0 + \int_0^\infty \Big[\left(L_2 + M_2 k x_3\right) \sin k x_2 + \left(P_2 + Q_2 k x_3\right) \cos k x_2 \Big] k^{-1} e^{-k x_3} \mathrm{d}k , \tag{6}$$

where U_0 is given in equation (4) and the unknowns L_1, M_1, P_1, Q_1 and L_2, M_2, P_2, Q_2 are to be determined from the boundary conditions.

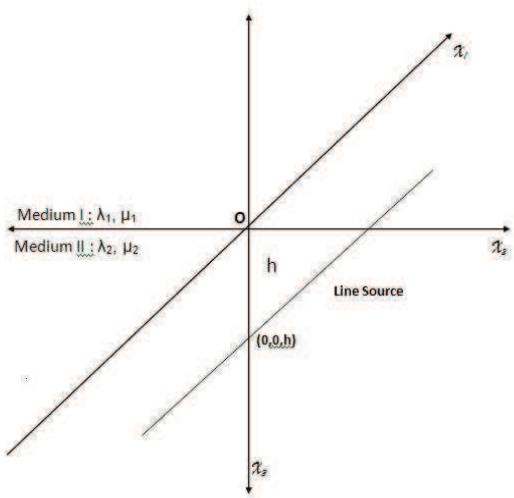

Fig. 1. Two half-spaces in smooth contact with a line source in the lower half-space at (0, 0, h)

Since the interface is $x_3 = 0$, then smooth contact implies that u_3 and τ_{33} are continuous but τ_{23} vanishes at the interface. Since the half-spaces are assumed to be in smooth contact along the plane $x_3 = 0$, the boundary conditions at the interface $x_3 = 0$ are

$$\left.\begin{array}{ll} \tau_{33}^{(1)} = \tau_{33}^{(2)} , & \tau_{23}^{(1)} = 0 , \\ \mathrm{u}_3^{(1)} = \mathrm{u}_3^{(2)} , & \tau_{23}^{(2)} = 0 . \end{array}\right\} \tag{7}$$

Due to discontinuity in horizontal displacement u_2 at $x_3 = 0$, there may be a slip between the two media.

From equations (1) – (6), we get the following integral expressions for the stresses and the displacements for the two media:

$$\tau_{22}^{(1)} = \int_0^\infty \Big[\left(L_1 + 2M_1 + M_1 k x_3\right) \sin k x_2 + \left(P_1 + 2Q_1 + Q_1 k x_3\right) \cos k x_2 \Big] e^{k x_3} k \, \mathrm{d}k, \tag{8}$$

$$\tau_{23}^{(1)} = \int_0^\infty \Big[-\left(L_1 + M_1 + M_1 k x_3\right) \cos k x_2 + \left(P_1 + Q_1 + Q_1 k x_3\right) \sin k x_2 \Big] e^{k x_3} k \, \mathrm{d}k , \tag{9}$$

$$\tau_{33}^{(1)} = -\int_0^\infty \Big[\left(L_1 + M_1 k x_3\right) \sin k x_2 + \left(P_1 + Q_1 k x_3\right) \cos k x_2 \Big] e^{k x_3} k \, \mathrm{d}k , \tag{10}$$

$$\begin{aligned} \tau_{22}^{(2)} = & \int_0^\infty \Big[\left(L_0 - 2M_0 + M_0 k \left|x_3 - h\right|\right) e^{-k\left|x_3 - h\right|} + \left(L_2 - 2M_2 + M_2 k x_3\right) e^{-k x_3} \Big] \sin k x_2 k \, \mathrm{d}k \\ & + \int_0^\infty \Big[\left(P_0 - 2Q_0 + Q_0 k \left|x_3 - h\right|\right) e^{-k\left|x_3 - h\right|} + \left(P_2 - 2Q_2 + Q_2 k x_3\right) e^{-k x_3} \Big] \cos k x_2 k \, \mathrm{d}k , \end{aligned} \tag{11}$$

$$\begin{aligned} \tau_{23}^{(2)} = & \int_0^\infty \Big[\pm\left(L_0 - M_0 + M_0 k \left|x_3 - h\right|\right) e^{-k\left|x_3 - h\right|} + \left(L_2 - M_2 + M_2 k x_3\right) e^{-k x_3} \Big] \cos k x_2 k \, \mathrm{d}k \\ & - \int_0^\infty \Big[\pm\left(P_0 - Q_0 + Q_0 k \left|x_3 - h\right|\right) e^{-k\left|x_3 - h\right|} + \left(P_2 - Q_2 + Q_2 k x_3\right) e^{-k x_3} \Big] \sin k x_2 k \, \mathrm{d}k , \end{aligned} \tag{12}$$

$$\begin{aligned} \tau_{33}^{(2)} = & -\int_0^\infty \Big[\left(L_0 + M_0 k \left|x_3 - h\right|\right) e^{-k\left|x_3 - h\right|} + \left(L_2 + M_2 k x_3\right) e^{-k x_3} \Big] \sin k x_2 k \, \mathrm{d}k \\ & - \int_0^\infty \Big[\left(P_0 + Q_0 k \left|x_3 - h\right|\right) e^{-k\left|x_3 - h\right|} + \left(P_2 + Q_2 k x_3\right) e^{-k x_3} \Big] \cos k x_2 k \, \mathrm{d}k , \end{aligned} \tag{13}$$

$$2\mu_1 u_2^{(1)} = \int_0^\infty \left[-\left(L_1 + \frac{M_1}{\alpha_1} + M_1 k x_3\right) \cos k x_2 + \left(P_1 + \frac{Q_1}{\alpha_1} + Q_1 k x_3\right) \sin k x_2 \right] e^{k x_3} \mathrm{d}k , \tag{14}$$

$$2\mu_1 u_3^{(1)} = -\int_0^\infty \left[\left(L_1 + M_1 - \frac{M_1}{\alpha_1} + M_1 k x_3\right) \sin k x_2 + \left(P_1 + Q_1 - \frac{Q_1}{\alpha_1} + Q_1 k x_3\right) \cos k x_2 \right] e^{k x_3} \mathrm{d}k , \tag{15}$$

$$\begin{aligned} 2\mu_2 u_2^{(2)} = & -\int_0^\infty \left[\left(L_0 - \frac{M_0}{\alpha_2} + M_0 k \left|x_3 - h\right|\right) e^{-k\left|x_3 - h\right|} + \left(L_2 - \frac{M_2}{\alpha_2} + M_2 k x_3\right) e^{-k x_3} \right] \cos k x_2 \mathrm{d}k \\ & + \int_0^\infty \left[\left(P_0 - \frac{Q_0}{\alpha_2} + Q_0 k \left|x_3 - h\right|\right) e^{-k\left|x_3 - h\right|} + \left(P_2 - \frac{Q_2}{\alpha_2} + Q_2 k x_3\right) e^{-k x_3} \right] \sin k x_2 \mathrm{d}k , \end{aligned} \tag{16}$$

$$
\begin{aligned}
2\mu_2 u_3^{(2)} = &\int_0^\infty \Big[\pm\Big(L_0 - M_0 + \frac{M_0}{\alpha_2} + M_0 k\left|x_3-h\right|\Big)e^{-k\left|x_3-h\right|} \\
&+ \Big(L_2 - M_2 + \frac{M_2}{\alpha_2} + M_2 k x_3\Big)e^{-kx_3}\Big]\sin kx_2\,\mathrm{d}k \\
&+\int_0^\infty \Big[\pm\Big(P_0 - Q_0 + \frac{Q_0}{\alpha_2} + Q_0 k\left|x_3-h\right|\Big)e^{-k\left|x_3-h\right|} \\
&+ \Big(P_2 - Q_2 + \frac{Q_2}{\alpha_2} + Q_2 k x_3\Big)e^{-kx_3}\Big]\cos kx_2\,\mathrm{d}k,
\end{aligned}
\tag{17}
$$

It is noticed from appendix that the coefficients L_0, M_0, P_0 and Q_0 have different values for $x_3 \gtrless h$; let $\bar{L}, \bar{M}, \bar{P}$ and $\bar{Q}$ be the values of L_0, M_0, P_0 and Q_0 respectively, valid for $x_3 < h$. Then from equations (9) to (17) and the boundary conditions (7), we obtain

$$
\begin{aligned}
u^{(1)} = c_1\Bigg[&\bar{L}\left\{\frac{x_2x_3}{R^2} - \tan^{-1}\left(\frac{x_2}{h-x_3}\right)\right\} + \bar{P}\left\{\frac{x_3(h-x_3)}{R^2}\right. \\
&\left.+\log R\right\} + \bar{M}\left\{-\frac{x_2h}{R^2} + \frac{2hx_2x_3(h-x_3)}{R^4}\right\} \\
&+\bar{Q}\left\{-\frac{h^2}{R^2} + \frac{2hx_3(x_3-h)^2}{R^4}\right\}\Bigg]
\end{aligned}
\tag{18}
$$

$$
\begin{aligned}
\tau_{22}^{(1)} = c_1\Bigg[&\bar{L}\left\{\frac{2x_2(h-2x_3)}{R^4} + \frac{8x_2x_3(h-x_3)^2}{R^6}\right\} \\
&+\bar{P}\left\{-\frac{1}{R^2} + \frac{2(h-x_3)(h-4x_3)}{R^4}\right. \\
&\left.+\frac{8x_3(h-x_3)^3}{R^6}\right\} + \bar{M}\left\{-\frac{2x_2h}{R^4}\right. \\
&\left.+\frac{8hx_2(h-x_3)(h-4x_3)}{R^6} + \frac{48hx_2x_3(h-x_3)^3}{R^8}\right\} \\
&+\bar{Q}\left\{-\frac{6h(h-2x_3)}{R^4} + \frac{8h(h-7x_3)(h-x_3)^2}{R^6}\right. \\
&\left.+\frac{48hx_3(h-x_3)^4}{R^8}\right\}\Bigg],
\end{aligned}
\tag{19}
$$

$$
\begin{aligned}
\tau_{23}^{(1)} = c_1x_3\Bigg[&-\frac{2(h-x_3)}{R^4}\bar{L}\left\{\frac{4(h-x_3)^2}{R^2} - 3\right\} \\
&+\frac{2x_2}{R^4}\bar{P}\left\{\frac{4(h-x_3)^2}{R^2} - 1\right\} - \frac{6h}{R^4}\bar{M} \\
&\left\{\frac{8(h-x_3)^4}{R^4} - \frac{8(h-x_3)^2}{R^2} + 1\right\} \\
&+\frac{24hx_2(h-x_3)}{R^6}\bar{Q}\left\{\frac{2(h-x_3)^2}{R^2} - 1\right\}\Bigg],
\end{aligned}
\tag{20}
$$

$$
\begin{aligned}
\tau_{33}^{(1)} = -c_1\Bigg[&\bar{L}\left\{\frac{8x_2x_3(h-x_3)^2}{R^6} - \frac{2x_2h}{R^4}\right\} \\
&+\bar{P}\left\{\frac{1}{R^2} - \frac{2(h-x_3)(h+2x_3)}{R^4} + \frac{8x_3(h-x_3)^3}{R^6}\right\} \\
&+\bar{M}\left\{\frac{2x_2h}{R^4} - \frac{8hx_2(h-x_3)(h+2x_3)}{R^6}\right. \\
&\left.+\frac{48hx_2x_3(h-x_3)^3}{R^8}\right\} + \bar{Q}\left\{\frac{6h^2}{R^4}\right. \\
&\left.-\frac{8h(h+5x_3)(h-x_3)^2}{R^6} + \frac{48hx_3(h-x_3)^4}{R^8}\right\}\Bigg],
\end{aligned}
\tag{21}
$$

$$
\begin{aligned}
2\mu_1 u_2^{(1)} = \frac{c_1}{R^2}\Bigg[&-\left\{\left(\frac{1}{\alpha_1}-1\right)h - \frac{x_3}{\alpha_1} + \frac{2x_3(x_3-h)^2}{R^2}\right\}\bar{L} \\
&+\left\{\left(\frac{1}{\alpha_1}-1\right)x_2 + \frac{2x_2x_3(h-x_3)}{R^2}\right\}\bar{P} \\
&+\left\{\left(\frac{1}{\alpha_1}-1\right)h + \frac{2h(h-x_3)}{R^2}\left(\left(\frac{1}{\alpha_1}-1\right)(h-x_3) - 3x_3\right)\right. \\
&\left.+\frac{8hx_3(h-x_3)^3}{R^4}\right\}\bar{M} + \left\{\frac{2x_2h}{R^2}\left\{\left(\frac{1}{\alpha_1}-1\right)(h-x_3)\right.\right. \\
&\left.\left.x_3\right\} + \frac{8hx_2x_3(x_3-h)^2}{R^4}\right\}\bar{Q}\Bigg],
\end{aligned}
\tag{22}
$$

$$
\begin{aligned}
2\mu_1 u_3^{(1)} = \frac{C_1}{R^2}\Bigg[\Bigg[&\left\{\frac{x_2}{\alpha_1}+\frac{2x_2x_3\left(x_3-h\right)}{R^2}\right\}\bar{L}+\left\{x_3\left(1-\frac{1}{\alpha_1}\right)+\frac{h}{\alpha_1}\right.\\
&\left.-\frac{2x_3\left(x_3-h\right)^2}{R^2}\right\}\bar{P}+\left\{2h\left(x_3+\frac{\left(h-x_3\right)}{\alpha_1}\right)\frac{x_2}{R^2}\right.\\
&\left.-\frac{8hx_2x_3\left(x_3-h\right)^2}{R^4}\right\}\bar{M}-\left\{-\frac{2h\left(x_3-h\right)}{R^2}\left(\frac{\left(x_3-h\right)}{\alpha_1}-3x_3\right)\right.\\
&\left.-\frac{h}{\alpha_1}+\frac{8hx_3\left(h-x_3\right)^3}{R^4}\right\}\bar{Q}\Bigg]\Bigg],
\end{aligned}
\tag{23}
$$

$$
\begin{aligned}
u^{(2)} = L_0\tan^{-1}&\left(\frac{x_2}{\left|x_3-h\right|}\right)-P_0\log R+\frac{M_0x_2\left|x_3-h\right|}{R^2}\\
&+\frac{Q_0\left(x_3-h\right)^2}{R^2}+\bar{L}\left\{\frac{c_2x_2x_3}{S^2}+\left(1+c_2\right)\tan^{-1}\left(\frac{x_2}{\left(x_3+h\right)}\right)\right\}\\
&-\bar{P}\left\{\left(1+c_2\right)\log S-\frac{c_2x_3\left(x_3+h\right)}{S^2}\right\}+\frac{x_2\bar{M}}{S^2}\left\{x_3+h\right.\\
&\left.+hc_2+\frac{2c_2hx_3\left(x_3+h\right)}{S^2}\right\}+\frac{\bar{Q}}{S^2}\left\{\left(x_3+h\right)^2+h^2c_2\right.\\
&\left.+\frac{2c_2hx_3\left(x_3+h\right)^2}{S^2}\right\},
\end{aligned}
\tag{24}
$$

$$
\begin{aligned}
\tau_{22}^{(2)} = \frac{2L_0x_2\left|x_3-h\right|}{R^4}&+\frac{P_0}{R^2}\left\{-1+\frac{2\left(x_3-h\right)^2}{R^2}\right\}\\
&+\frac{2M_0x_2\left|x_3-h\right|}{R^4}\left\{-3+\frac{4\left(x_3-h\right)^2}{R^2}\right\}\\
&+\frac{2Q_0}{R^2}\left\{1-\frac{5\left(x_3-h\right)^2}{R^2}+\frac{4\left(x_3-h\right)^4}{R^4}\right\}\\
&+\frac{2x_2\bar{L}}{S^4}\left\{x_3+h-c_2\left(h+2x_3\right)\right.\\
&\left.+\frac{4c_2x_3\left(x_3+h\right)^2}{S^2}\right\}+\frac{2x_2\bar{M}}{S^4}\left[-3\left(x_3+h\right)\right.\\
&+hc_2-\frac{4\left(x_3+h\right)}{S^2}-\left\{\frac{24hx_3\left(x_3+h\right)^2}{S^4}\right.\\
&\left.\left.+\left(x_3+h\right)-hc_2\left(h+4x_3\right)\right\}\right]+\frac{\bar{P}}{S^2}\left\{\frac{8c_2x_3\left(x_3+h\right)^3}{S^4}\right.\\
&\left.+c_2-1+\frac{2\left(x_3+h\right)\left\{x_3+h-c_2\left(h+4x_3\right)\right\}}{S^2}\right\}\\
&+\frac{2\bar{Q}}{S^2}\left\{1+\frac{-5\left(x_3+h\right)^2+3hc_2\left(h+2x_3\right)}{S^2}\right.\\
&+\frac{4\left(x_3+h\right)^2\left\{\left(x_3+h\right)^2-hc_2\left(h+7x_3\right)\right\}}{S^4}\\
&\left.+\frac{24c_2hx_3\left(x_3+h\right)^4}{S^6}\right\},
\end{aligned}
\tag{25}
$$

$$
\begin{aligned}
\tau_{23}^{(2)} = -\frac{2P_0x_2\left(x_3-h\right)}{R^4}&\pm\frac{L_0}{R^2}\left\{-1+\frac{2\left(x_3-h\right)^2}{R^2}\right\}\\
&+\frac{4Q_0x_2\left(x_3-h\right)}{R^4}\left\{1-\frac{2\left(x_3-h\right)^2}{R^2}\right\}\\
&\pm\frac{M_0}{R^2}\left\{1-\frac{8\left(x_3-h\right)^2}{R^2}+\frac{8\left(x_3-h\right)^4}{R^4}\right\}\\
&-\frac{2x_2\bar{P}}{S^4}\left\{\left(x_3+h\right)-c_2x_3+\frac{4c_2x_3\left(x_3+h\right)^2}{S^2}\right\}\\
&+\frac{\bar{L}}{S^2}\left\{-1+\frac{2\left(x_3+h\right)\left\{x_3+h-3c_2x_3\right\}}{S^2}\right.\\
&\left.+\frac{8c_2x_3\left(x_3+h\right)^3}{S^4}\right\}+\frac{\bar{M}}{S^2}\left\{1+\frac{-8\left(x_3+h\right)^2}{S^2}\right.\\
&+\frac{6c_2hx_3}{S^2}+\frac{8\left(x_3+h\right)^2\left\{\left(x_3+h\right)^2-6c_2hx_3\right\}}{S^4}\\
&\left.+\frac{48c_2hx_3\left(x_3+h\right)^4}{S^6}\right\}-\frac{4x_2\left(x_3+h\right)\bar{Q}}{S^4}\\
&\left\{-1+\frac{2\left\{\left(x_3+h\right)^2-3c_2hx_3\right\}}{S^2}+\frac{12c_2hx_3\left(x_3+h\right)^2}{S^4}\right\},
\end{aligned}
\tag{26}
$$

$$\begin{aligned}
\tau_{33}^{(2)} =& -\frac{2L_0 x_2 \left|x_3-h\right|}{R^4} - \frac{P_0}{R^2}\left\{-1+\frac{2(x_3-h)^2}{R^2}\right\} \\
&+\frac{2M_0 x_2\left|x_3-h\right|}{R^4}\left\{1-\frac{4(x_3-h)^2}{R^2}\right\} \\
&+\frac{2Q_0(x_3-h)^2}{R^4}\left\{3-\frac{4(x_3-h)^2}{R^2}\right\} \\
&-\frac{2x_2\bar{L}}{S^4}\left\{x_3+h(1+c_2)+\frac{4c_2 x_3(x_3+h)^2}{S^2}\right\} \\
&-\frac{2x_2\bar{M}}{S^4}\left\{-(x_3+h+hc_2)+\frac{4(x_3+h)}{S^2}\right. \\
&-\frac{\bar{P}}{S^2}\left\{-c_2-1+\frac{2(x_3+h)\{x_3+h+c_2(h-2x_3)\}}{S^2}\right. \\
&\left.+\frac{8c_2x_3(x_3+h)^3}{S^4}\right\}-\frac{2\bar{Q}}{S^4}\left\{-3\{(x_3+h)^2+h^2c_2\}\right. \\
&+\frac{4(x_3+h)^2}{S^2}\left\{(x_3+h)^2+hc_2(h-5x_3)\right\} \\
&\left.+\frac{24c_2hx_3(x_3+h)^4}{S^4}\right\}, \qquad (27)
\end{aligned}$$

$$\begin{aligned}
2\mu_2 u_2^{(2)} =& -\frac{L_0\left|x_3-h\right|}{R^2}+\frac{P_0x_2}{R^2}+\frac{M_0\left|x_3-h\right|}{R^2} \\
&\left[\left\{\left(1+\frac{1}{\alpha_2}\right)-\frac{2(x_3-h)^2}{R^2}\right\}\right. \\
&+\frac{Q_0x_2}{R^2}\left\{-\frac{1}{\alpha_2}+\frac{2(x_3-h)^2}{R^2}\right\} \\
&-\frac{\bar{L}}{S^2}\left\{(x_3+h)\left(D_1-\frac{c_2}{\alpha_2}\right)-x_3c_2\left(\frac{2(x_3+h)^2}{S^2}-1\right)\right\} \\
&+\frac{x_2\bar{P}}{S^2}\left\{\left(D_1-\frac{c_2}{\alpha_2}\right)+\frac{2x_3c_2(x_3+h)}{S^2}\right\} \\
&-\frac{\bar{M}}{S^2}\left\{-\frac{(x_3+h)}{\alpha_2}+\left(x_3+h\left(D_1-\frac{c_2}{\alpha_2}\right)\right)\right. \\
&\left(\frac{2(x_3+h)^2}{S^2}-1\right)+\frac{2hx_3c_2(x_3+h)}{S^2} \\
&\left(\frac{4(x_3+h)^2}{S^2}-3\right)+\frac{x_2\bar{Q}}{S^2}\left[-\frac{1}{\alpha_2}+\frac{2(x_3+h)}{S^2}\right. \\
&\left.\left.\left(x_3+h\left(D_1-\frac{c_2}{\alpha_2}\right)\right)+\frac{2hx_3c_2}{S^2}\left(\frac{4(x_3+h)^2}{S^2}-1\right)\right]\right], \qquad (28)
\end{aligned}$$

$$\begin{aligned}
2\mu_2 u_3^{(2)} =& \pm\frac{L_0x_2}{R^2}+\frac{P_0(x_3-h)}{R^2}\pm\frac{M_0x_2}{R^2} \\
&\left[\left\{-1+\frac{1}{\alpha_2}+\frac{2(x_3-h)^2}{R^2}\right\}+\frac{Q_0(x_3-h)}{R^2}\right. \\
&\left\{-2+\frac{1}{\alpha_2}+\frac{2(x_3-h)^2}{R^2}\right\}+\frac{x_2\bar{L}}{S^2}\left\{1+\frac{c_2}{\alpha_2}\right. \\
&\left.+\frac{2x_3c_2(x_3+h)}{S^2}\right\}+\bar{P}\left\{(x_3+h)\left(1+\frac{c_2}{\alpha_2}\right)\right. \\
&\left.\left.+x_3c_2\left(\frac{2(x_3+h)^2}{S^2}-1\right)\right\}\right]+\frac{x_2\bar{M}}{S^2} \\
&\left\{\left(\frac{1}{\alpha_2}-1\right)+2\left(x_3+h+\frac{hc_2}{\alpha_2}\right)\frac{(x_3+h)}{S^2}+\frac{2hx_3c_2}{S^2}\right. \\
&\left.\left.\left(\frac{4(x_3+h)^2}{S^2}-1\right)\right\}\right]+\frac{\bar{Q}}{S^2}\left\{(x_3+h)\left(\frac{1}{\alpha_2}-1\right)\right. \\
&+\left(x_3+h+\frac{hc_2}{\alpha_2}\right)\left(\frac{2(x_3+h)^2}{S^2}-1\right) \\
&\left.+\frac{2hx_3c_2(x_3+h)}{S^2}\left(\frac{4(x_3+h)^2}{S^2}-3\right)\right\}, \qquad (29)
\end{aligned}$$

where

$$(z \neq h),\ R^2 = x_2^2+(x_3-h)^2,\ S^2 = x_2^2+(x_3+h)^2,$$

The expressions given in equations (18)-(29) are in terms of the source coefficients L_0, M_0, P_0 and Q_0. The results for the Airy stress functions and the stresses in the two half-spaces for a vertical tensile source on putting the values of the source coefficients from given appendix are as follows:

$$u^{(1)} = \frac{c_1\mu b\,ds}{2\pi(1-\sigma)}\left[\frac{x_3(h-x_3)}{R^2} + \log R + \frac{h^2}{R^2} - \frac{2hx_3(x_3-h)^2}{R^4}\right\}, \tag{30}$$

$$\tau_{22}^{(1)} = \frac{c_1\mu_2 b\,ds}{2\pi(1-\sigma)}\left\{-\frac{1}{R^2} + \frac{2}{R^4}\{4h^2-11hx_3+4x_3^2\} + \frac{8(h-x_3)^2}{R^6}\{8hx_3-h^2-x_3^2\} - \frac{48hx_3(h-x_3)^4}{R^8}\right\}, \tag{31}$$

$$\tau_{23}^{(1)} = \frac{c_1 x_2 x_3\mu_2 b\,ds}{\pi(1-\sigma)}\left\{-\frac{1}{R^4} + \frac{4(h-x_3)(4h-x_3)}{R^6} - \frac{24h(h-x_3)^3}{R^8}\right\}, \tag{32}$$

$$\tau_{33}^{(1)} = -\frac{c_1\mu_2 b\,ds}{2\pi(1-\sigma)}\left[\frac{1}{R^2} - \frac{2}{R^4}\{4h^2+hx_3-2x_3^2\} + \frac{8(h-x_3)^2}{R^6}\{6hx_3+h^2-x_3^2\} - \frac{48hx_3(h-x_3)^4}{R^8}\right], \tag{33}$$

$$u^{(2)} = \frac{\mu_2 b\,ds}{2\pi(1-\sigma)}\left[-\log R - \frac{(x_3-h)^2}{R^2} - \left\{(1+c_2)\log S - \frac{c_2x_3(x_3+h)}{S^2} - \frac{1}{S^2}\{(x_3+h)^2 + h^2c_2 + \frac{2c_2hx_3(x_3+h)^2}{S^2}\right\}\right]\Bigg], \tag{34}$$

$$\tau_{22}^{(2)} = \frac{\mu_2 b\,ds}{2\pi(1-\sigma)}\left[\frac{-3}{R^2} + \frac{12(x_3-h)^2}{R^4} - \frac{8(x_3-h)^4}{R^6} + \frac{c_2-3}{S^2} + \frac{2}{S^4}\{(6-4c_2)(x_3^2+h^2) + hx_3(12-11c_2) + \frac{8(x_3+h)^2}{S^6}\{(c_2-1)(x_3^2+h^2)+2hx_3(4c_2-1)\} - \frac{48c_2hx_3(x_3+h)^4}{S^8}\right], \tag{35}$$

$$\tau_{23}^{(2)} = \frac{-x_2\mu_2 b\,ds}{\pi(1-\sigma)}\left[\frac{3(x_3-h)}{R^4} - \frac{4(x_3-h)^3}{R^6} + \frac{1}{S^4}\{3(x_3+h)-c_2x_3\} + \frac{4(x_3+h)}{S^6}\{c_2x_3(x_3+4h)-(x_3+h)^2\} - \frac{24c_2hx_3(x_3+h)^3}{S^8}\right], \tag{36}$$

$$\tau_{33}^{(2)} = \frac{-\mu_2 b\,ds}{2\pi(1-\sigma)}\left[-\frac{1}{R^2} + \frac{8(x_3-h)^2}{R^4} - \frac{8(x_3-h)^4}{R^6} - \frac{(c_2+1)}{S^2} + \frac{2}{S^4}\left\{4(x_3+h)^2 + c_2\left(4h^2-2x_3^2-hx_3\right)\right\} + \frac{8(x_3+h)^2}{S^6}\left\{c_2\left(x_3^2-h^2-6hx_3\right)-(x_3+h)^2\right\} - \frac{48c_2hx_3(x_3+h)^4}{S^8}\right], \tag{37}$$

IV. NUMERICAL RESULTS

We want to compare the stresses for the smooth interface case with the corresponding stresses for the welded interface. For the numerical computations, we assume that the half-spaces are Poissonian $(\lambda_i = \mu_i)$ so that $\alpha_1 = \alpha_2 = \dfrac{2}{3}$

$$c_1 = \frac{-2\beta}{1+\beta} \qquad c_1^* = \frac{-3\beta}{2+\beta}$$

$$c_2 = \frac{-2}{1+\beta} \qquad c_2^* = \frac{\beta-1}{1+2\beta}$$

$$D_1 = \frac{\beta-1}{\beta+1} \qquad D_1^* = 1+c_2^*, \quad D_2^* = \frac{-\left(c_1^*+D_1^*\right)}{2}$$

We define the following dimensionless quantities $Y = \frac{x_2}{h}$, $Z = \frac{x_3}{h}$, where h is the distance of the line source from the interface. Let the dimensionless stresses for the welded interface(Kumar et.al 2005) be denoted by $P_{ij}^{*(1)}, P_{ij}^{*(2)}$ and the dimensionless stresses for the smooth interface be denoted by $P_{ij}^{(1)}, P_{ij}^{(2)}$. Then,

$$P_{ij}^{(1)} = \frac{\pi L^2}{\mu_2 b\,ds}\tau_{ij}^{(1)}, \quad P_{ij}^{*(1)} = \frac{\pi L}{\mu_2 b}\tau_{ij}^{*(1)} \tag{38}$$

From equations (31)-(33) and (35)-(37),we get the following expressions for the dimensionless stresses for the two cases for a vertical tensile line source:

$$P_{22}^{(1)} = \frac{C_1}{2(1-\sigma)}\left[-\frac{1}{A^2}+\frac{2}{A^4}\left(4-11Z+4Z^2\right) - \frac{8\left(1-Z\right)^2}{A^6}\left(Z^2-8Z+1\right)-\frac{48Z\left(1-Z\right)^4}{A^8}\right], \quad (39)$$

$$P_{23}^{(1)} = \frac{C_1 YZ}{(1-\sigma)}\left[-\frac{1}{A^4}+\frac{4(1-Z)(4-Z)}{A^6}-\frac{24(1-Z)^3}{A^8}\right] \quad (40)$$

$$P_{33}^{(1)} = \frac{-C_1}{2(1-\sigma)}\left[\frac{1}{A^2}-\frac{2}{A^4}\left(4+Z-2Z^2\right)+ \frac{8\left(1-Z\right)^2\left(6Z+1-Z^2\right)}{A^6}-\frac{48Z\left(1-Z\right)^4}{A^8}\right], \quad (41)$$

$$P_{22}^{(2)} = \frac{1}{2(1-\sigma)}\left[\frac{-3}{A^2}+\frac{12(Z-1)^2}{A^4}-\frac{8(Z-1)^4}{A^6} + \frac{(C_2-3)}{B^2}+\frac{2}{B^4}\left\{(6-4C_2)\left(Z^2+1\right)+(12-11C_2)Z\right\} + \frac{8(Z+1)^2}{B^6}\left\{(C_2-1)\left(Z^2+1\right)+2Z(4C_2-1)\right\} - \frac{48C_2Z(Z+1)^4}{B^8}\right], \quad (42)$$

$$P_{23}^{(2)} = -\frac{Y}{(1-\sigma)}\left[\frac{3(Z-1)}{A^4}-\frac{4(Z-1)^3}{A^6}+\frac{1}{B^4} \left\{3\left(Z+1\right)-C_2\right\}-\frac{4(Z+1)}{B^6}\left\{C_2Z(Z+4) -(Z+1)^2\right\}+\frac{24C_2Z(Z+1)^3}{B^8}\right], \quad (43)$$

$$P_{33}^{(2)} = -\frac{1}{2(1-\sigma)}\left[-\frac{1}{A^2}+\frac{8(Z-1)^2}{A^4}-\frac{8(Z-1)^4}{A^6} - \frac{(C_2+1)}{B^2}+\frac{2}{B^4}\left\{4(Z+1)^2+C_2\left(4-2Z^2-Z\right)\right\} + \frac{8(Z+1)^2}{B^6}\left\{C_2\left(Z^2-1-6Z\right)-(Z+1)^2\right\} - \frac{48C_2Z(Z+1)^4}{B^8}\right] \quad (44)$$

Following are the expressions for welded contact (Kumar et.al 2005) for the dimensionless stresses for the two cases for a vertical tensile line source:

$$P_{22}^{*(1)} = \frac{1}{2(1-\sigma)}\left[\frac{3(C_1-D_1)}{2A^2}+\frac{3(Z-1)}{A^4}\left\{Z(D_1-3C_1) +(C_1-3D_1)\right\}+\frac{8(Z-1)^3(C_1Z+D_1)}{A^6}\right], \quad (45)$$

$$P_{23}^{*(1)} = \frac{Y}{2(1-\sigma)}\left[\frac{\left\{3Z(D_1-C_1)+(C_1-5D_1)\right\}}{A^4} +\frac{8(Z-1)^2(C_1Z+D_1)}{A^6}\right], \quad (46)$$

$$P_{33}^{*(1)} = -\frac{1}{2(1-\sigma)}\left[\frac{(C_1+3D_1)}{2A^2}-\frac{Y^2(C_1+3D_1)}{A^4} -\frac{2(1-Z)(C_1Z+D_1)}{A^4}+\frac{8Y^2(1-Z)(C_1Z+D_1)}{A^6}\right], \quad (47)$$

$$P_{22}^{*(2)} = \frac{1}{2(1-\sigma)}\left[\frac{-3}{A^2}+\frac{12(Z-1)^2}{A^4}+\frac{\left(D_2+5C_2\right)}{B^2} -\frac{8(Z-1)^4}{A^6}-\frac{2(Z+1)^2\left(D_2+7C_2\right)}{B^4} -\frac{4C_2(Z+1)(3Z+4)}{B^4}+\frac{2C_2(Z^3-1+6Z)}{B^4} +\frac{8C_2(Z+1)^2(10Z+1+3Z^2)}{B^6} +\frac{16C_2(Z+1)^2(4Z+1)}{B^6}-\frac{96C_2Z(Z+1)^4}{B^8}\right], \quad (48)$$

$$P_{23}^{*(2)} = \frac{Y}{2(1-\sigma)}\left[\frac{4(Z-1)}{A^2}+\frac{2(Z-1)}{A^4} -\frac{4(Z-1)^3}{A^4}-\frac{2(Z+1)(D_2+C_2)}{B^4} -\frac{4C_2(2Z+1)}{B^4}+\frac{8C_2(Z+1)(6Z+Z^2-1)}{B^6} +\frac{16C_2(Z+1)^3}{B^6}-\frac{96C_2Z(Z+1)^3}{B^8}\right], \quad (49)$$

$$P_{33}^{*(2)} = \frac{1}{2(1-\sigma)}\left[-\frac{1}{A^2}-\frac{2(Z-1)^2}{A^2}+\frac{2Y^2}{A^4} -\frac{4Y^2(Z-1)^2}{A^4}+\frac{(D_2-C_2)}{B^2}-\frac{2Y^2(D_2-C_2)}{B^4} -\frac{4YC_2(Z+1)}{B^4}-\frac{2C_2(Z^2-1+2Z)}{B^4}\right.$$

$$+\frac{16c_2 z(z+1)(Y^2+1+z)}{B^6}+\frac{8c_2 Y^2(z^2-1+2z)}{B^6}-\frac{96c_2 z Y^2(z+1)^2}{B^8}\Bigg], \tag{50}$$

V. DISCUSSION

Figures 2(a)-2(d), 3(a)-3(d) and 4(a)-4(d) show the variation of the dimensionless stresses P_{22}, P_{23} and P_{33} at the interface with the horizontal distance from the fault and the figures 5(a)-5(d), 6(a)-6(d) and 7(a)-7(d) show the variation of the dimensionless stresses P_{22}, P_{23} and P_{33} at the interface with the depth from the fault for the rigidity contrast $\frac{\mu_1}{\mu_2}=\frac{1}{5}, 1, \frac{3}{2}, 5$, respectively for the two cases. In all the figures (from 2(a)-7(d)), $P_{ij}^{(1)}$ and $P_{ij}^{(2)}$ are dimensionless stresses in the case when contact of half-space is smooth, whereas $P_{ij}^{*(1)}$ and $P_{ij}^{*(2)}$ denote stresses when contact of half-space is welded. The superscript denotes the medium. Figure 2(a) shows variation of normal stress P_{22} for smooth contact and P_{22}^{*} in case of welded contact with distance from the fault for $\frac{\mu_1}{\mu_2}=\frac{1}{5}$. In the succeeding figures i.e. 2(b) to 2(d), we increase the rigidity ratio to $1, \frac{3}{2}, 5$ respectively. It is noticed that near the origin, the values of stress components $P_{22}^{(1)}$ and $P_{22}^{(2)}$ lies between $P_{22}^{*(1)}$ and $P_{22}^{*(2)}$. As we move away from the fault, this difference becomes less and approaches to zero for infinitely large distances from the fault. Figures 3(a) to 3(d) show variation of stress P_{23} and P_{23}^{*} with distance from the fault for the rigidity contrast $\frac{\mu_1}{\mu_2}=\frac{1}{5}, 1, \frac{3}{2}$ and 5 respectively. As the value of rigidity contrast increases the value of stress components $P_{23}^{*(1)}$ and $P_{23}^{*(2)}$ decreases in welded contact. It is also observed in figures from 2(a) to 4(d) that initially, the value of stress is larger in medium I as compared to medium II for smooth contact. components P_{22}, P_{23} and P_{33}.

Variation of stresses with depth from the fault is shown in figures 5(a) to 7(d). Here, too, variation is examined for same rigidity ratios as explained above. It is observed that initially the values of stresses P_{22} and P_{33} are nearly zero.

VI. CONCLUSION

In both cases i.e in welded contact and smooth contact, stresses tend to zero as x_2 and x_3 approaches to infinity respectively. We notice that the magnitude of stresses for smooth contact model are greater than the magnitude of stresses for welded contact model up to some epicentral distances and then decreases rapidly. Also, in case of smooth contact, the behavior of stresses at the interface for the two half-spaces is opposite to each other i.e., when it is increasing in medium I, it is decreasing for medium II and vice versa. We observe that a change in value of $\frac{\mu_1}{\mu_2}$ alters the magnitude of the stresses.

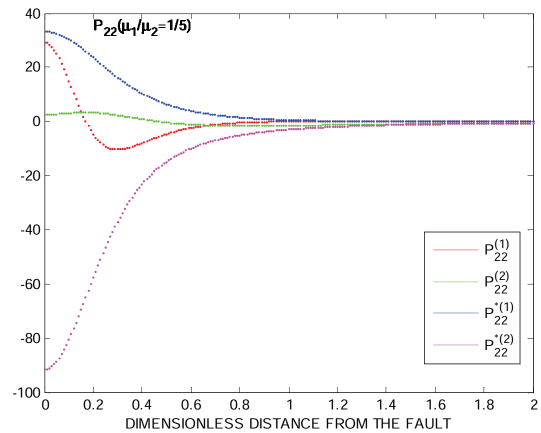

Fig. 2(a) Variation of the dimensionless normal stress P_{22} with distance from the fault for $\mu_1/\mu_2 = 1/5$ for smooth contact and welded contact.

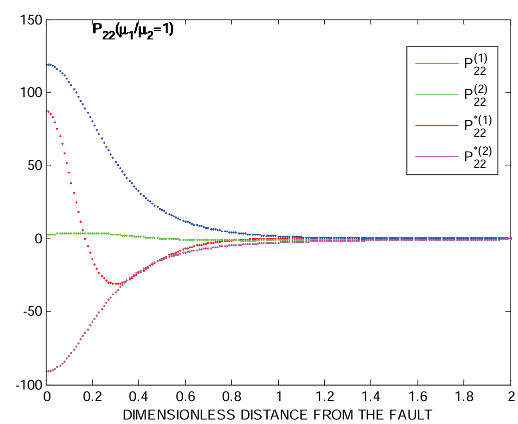

Fig. 2(b) Variation of the dimensionless normal stress P_{22} with distance from the fault for $\mu_1/\mu_2 = 1$ for smooth contact and welded contact.

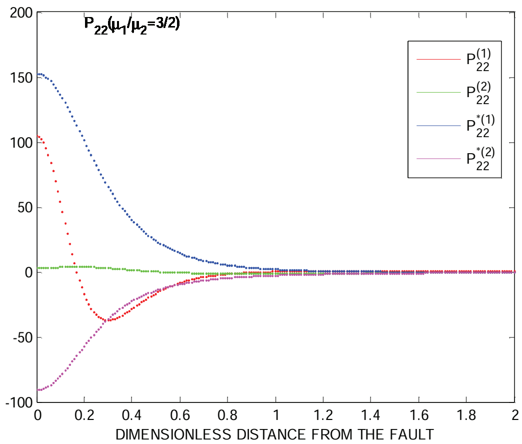

Fig. 2(c) Variation of the dimensionless normal stress P_{22} with distance from the fault for $\mu_1/\mu_2 = 3/2$ for smooth contact and welded contact.

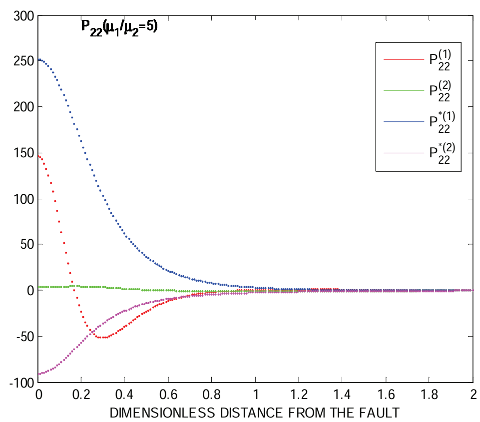

Fig. 2(d) Variation of the dimensionless normal stress P_{22} with distance from the fault for $\mu_1/\mu_2 = 5$ for smooth contact and welded contact.

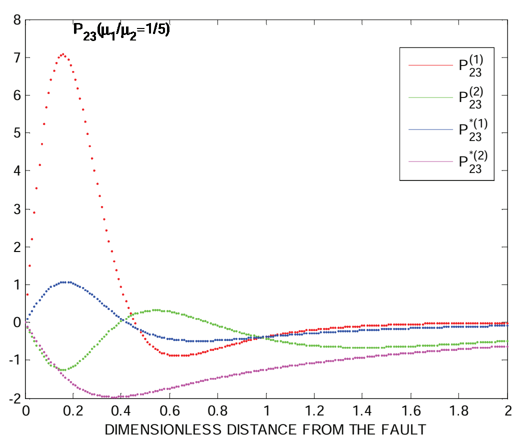

Fig. 3(a) Variation of the dimensionless shear stress P_{23} with distance from the fault for $\mu_1/\mu_2 = 1/5$ for smooth contact and welded contact.

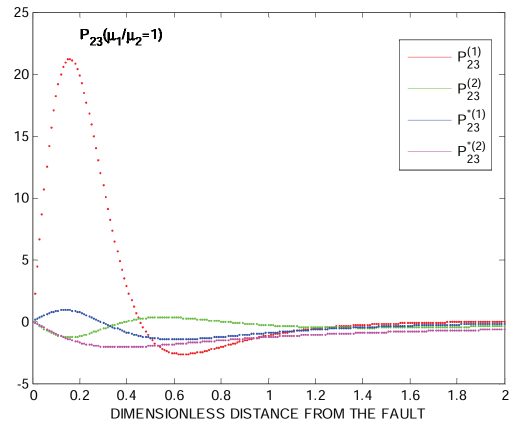

Fig. 3(b) Variation of the dimensionless shear stress P_{23} with distance from the fault for $\mu_1/\mu_2 = 1$ for smooth contact and welded contact.

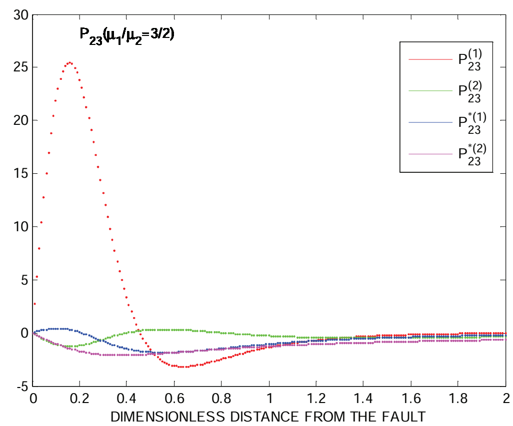

Fig. 3(c) Variation of the dimensionless shear stress P_{23} with distance from the fault for $\mu_1/\mu_2 = 3/2$ for smooth contact and welded contact.

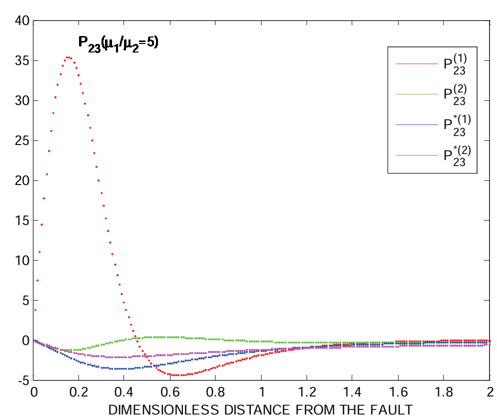

Fig. 3(d) Variation of the dimensionless shear stress P_{23} with distance from the fault for $\mu_1/\mu_2 = 5$ for smooth contact and welded contact.

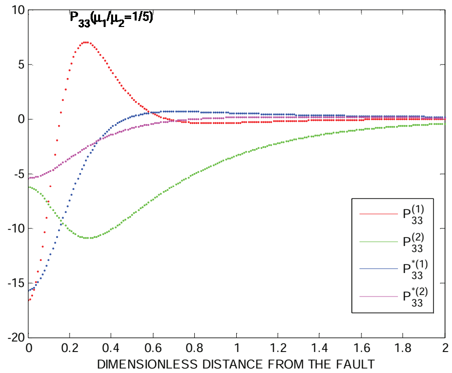

Fig. 4(a) Variation of the dimensionless normal stress P_{33} with distance from the fault for $\mu_1/\mu_2=1/5$ for smooth contact and welded contact.

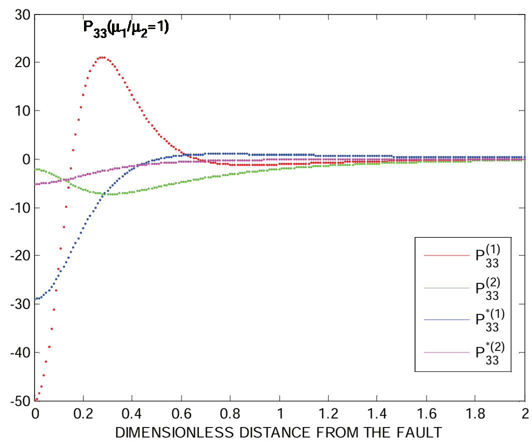

Fig. 4(b Variation of the dimensionless normal stress P_{33} with distance from the fault for $\mu_1/\mu_2=1$ for smooth contact and welded contact.

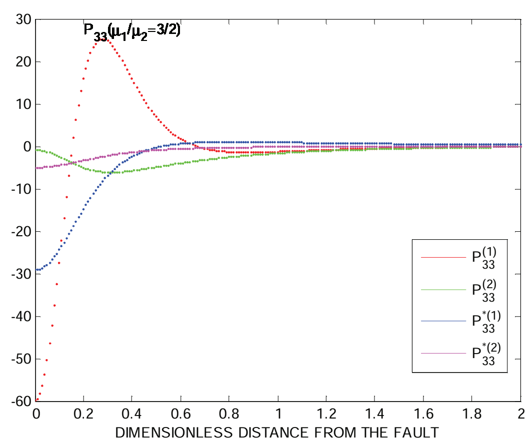

Fig. 4(c) Variation of the dimensionless normal stress P_{33} with distance from the fault for $\mu_1/\mu_2=3/2$ for smooth contact and welded contact.

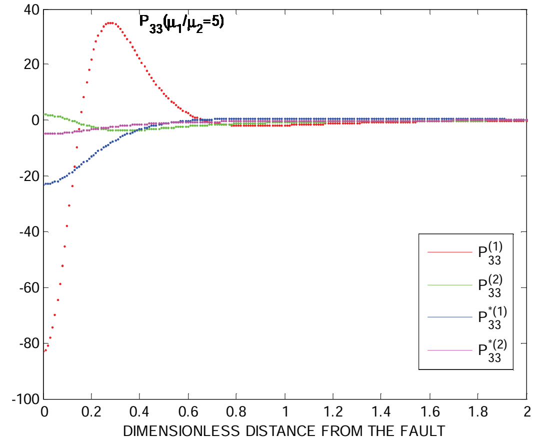

Fig. 4(d) Variation of the dimensionless normal stress P_{33} with distance from the fault for $\mu_1/\mu_2=5$ for smooth contact and welded contact.

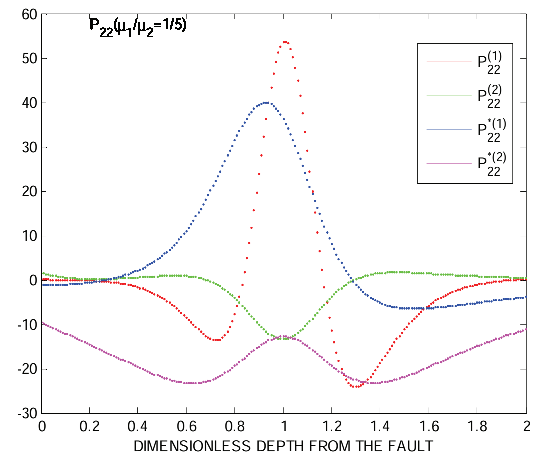

Fig. 5(a) Variation of the dimensionless normal stress P_{22} with depth from the fault for $\mu_1/\mu_2=1/5$ for smooth contact and welded contact.

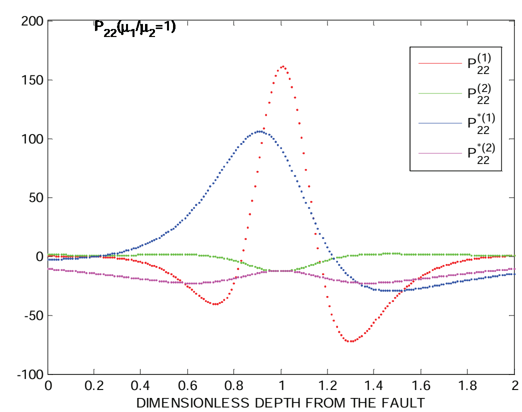

Fig. 5(b) Variation of the dimensionless normal stress P_{22} with depth from the fault for $\mu_1/\mu_2=1$ for smooth contact and welded contact.

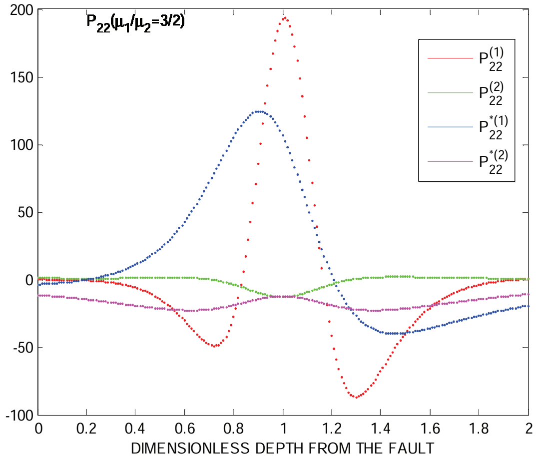

Fig. 5(c) Variation of the dimensionless normal stress P_{22} with depth from the fault for $\mu_1/\mu_2 = 3/2$ for smooth contact and welded contact.

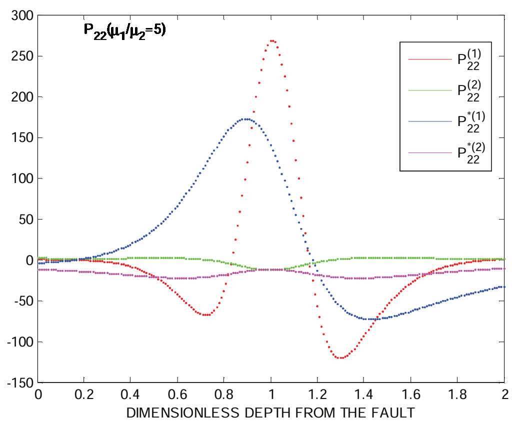

Fig. 5(d) Variation of the dimensionless normal stress P_{22} with depth from the fault for $\mu_1/\mu_2 = 5$ for smooth contact and welded contact.

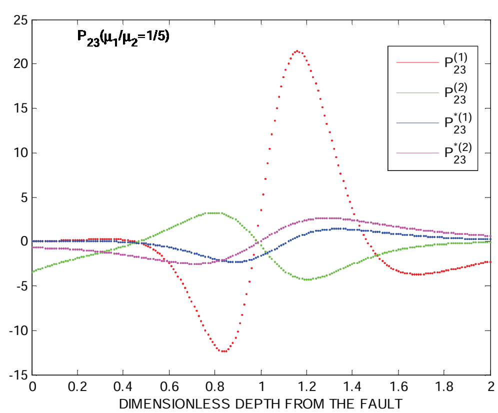

Fig. 6(a) Variation of the dimensionless shear stress P_{23} with depth from the fault for $\mu_1/\mu_2 = 1/5$ for smooth contact and welded contact

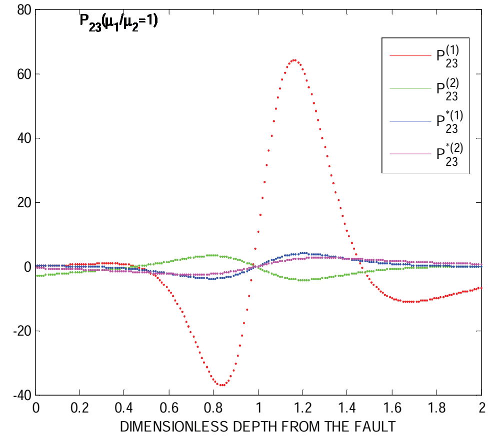

Fig. 6(b) Variation of the dimensionless shear stress P_{23} with depth from the fault for $\mu_1/\mu_2 = 1$ for smooth contact and welded contact.

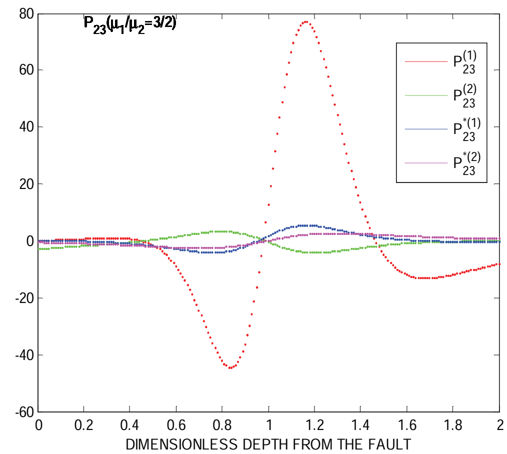

Fig. 6(**c**) Variation of the dimensionless shear stress P_{23} with depth from the fault for $\mu_1/\mu_2 = 3/2$ for smooth contact and welded contact.

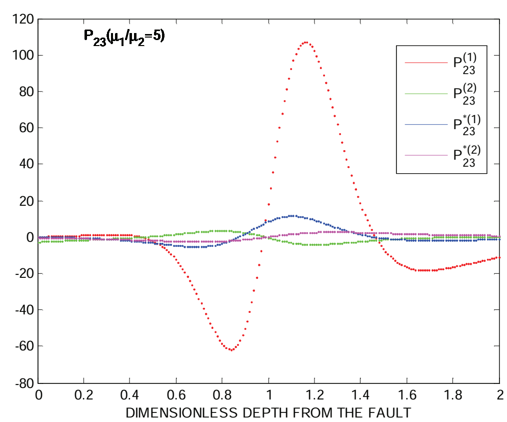

Fig. 6(d) Variation of the dimensionless shear stress P_{23} with depth from the fault for $\mu_1/\mu_2 = 5$ for smooth contact and welded contact.

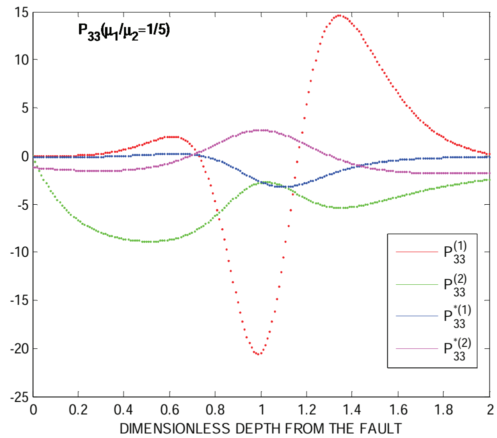

Fig. 7(a) Variation of the dimensionless normal stress P_{33} with depth from the fault for $\mu_1/\mu_2 = 1/5$ for smooth contact and welded contact.

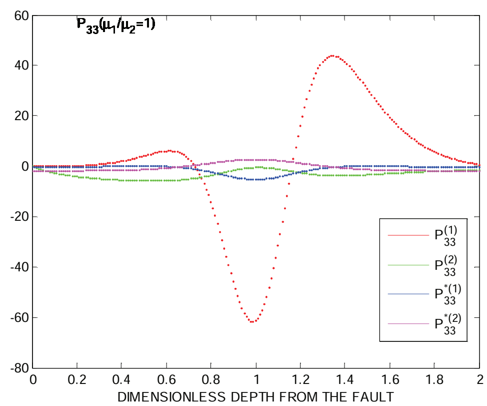

Fig. 7(b) Variation of the dimensionless normal stress P_{33} with depth from the fault for $\mu_1/\mu_2 = 1$ for smooth contact and welded contact.

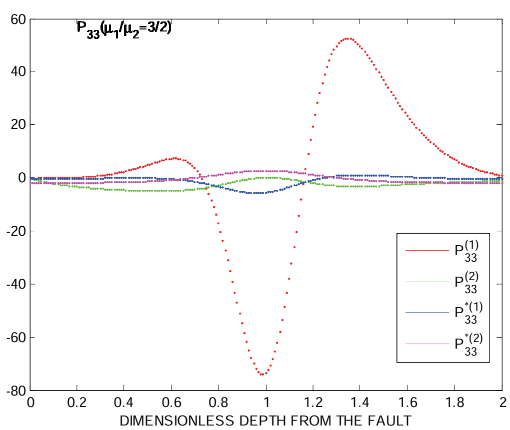

Fig. 7(c) Variation of the dimensionless normal stress P_{33} with depth from the fault for $\mu_1/\mu_2 = 3/2$ for smooth contact and welded contact.

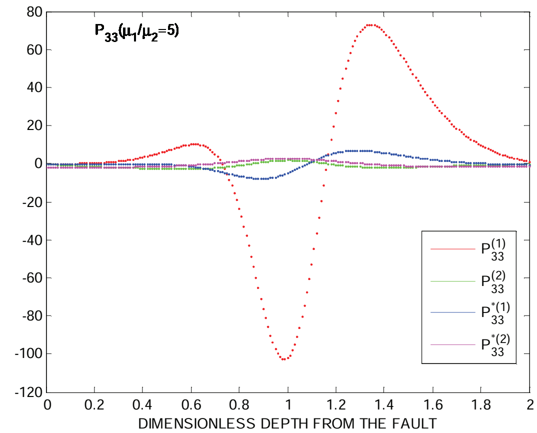

Fig. 7(d) Variation of the dimensionless normal stress P_{33} with depth from the fault for $\mu_1/\mu_2 = 5$ for smooth contact and welded contact.

APPENDIX

1. Vertical dip-slip fault

$$L_0 = P_0 = Q_0 = 0, \qquad M_0 = \pm \frac{\mu b\, ds}{2\pi(1-\sigma)}$$

2. Vertical tensile fault

$$L_0 = M_0 = 0, \qquad P_0 = -Q_0 = \frac{\mu b\, ds}{2\pi(1-\sigma)}$$

3. Horizontal tensile fault

$$L_0 = M_0 = 0, \qquad P_0 = Q_0 = \frac{\mu b\, ds}{2\pi(1-\sigma)}$$

The upper sing is for $x_3 > h$,the lower sign is for $x_3 < h$, b is the magnitude of the displacement dislocation and ds is the width of the line fault.

REFERENCES

[1]. Bonafede Maurizio and Danesi Stefania, "Near-field Modifications of Stress Induced by Dyke Injection at Shallow Depth", Geophys. J. Int., vol. 130, pp. 435-448, 1997.

[2]. Bonafede Maurizio and Rivalta Eleonora, "The Tensile Dislocation Problem in a Layered Elastic Medium", Geophys. J. Int., vol. 136, pp. 341-356, 1999.

[3]. Davis P M, "Surface Deformation Associated with a Dipping Hydrofracture", Journal of Geophysical Research", *vol. 88, pp. 5826-5836, 1983.*

[4]. Dundurs J and Hetenyi M, "Transmission of Force Between Two Semi-infinite Solids", ASME, Journal of Applied Mechanics, vol. 32, pp. 671-674, 1965.

[5]. Heaton T H and Heaton R E, "Static Deformation From Point Forces and Point Force Couples Located in Welded Elastic Poissonian Half-spaces:Implications for Seismic Moment Tensors", Bull. Seism. Soc. Am., vol. 79, pp. 813-841, 1989.

[6]. Kumari Gulshan, Singh Sarva Jit and Singh Kuldeep, "Static Deformation of Two Welded Half-spaces Caused by a Point Dislocation Source", Phys. Earth. Planet, Inter,vol. 73, pp. 53-76,1992.

[7]. Kumar Anil, Singh Sarva Jit and Singh Jagdish," Deformation of Two Welded Half-spaces due to a Long Inclined Tensile Fault", J. Earth Syst. Sci., vol. 114 ,pp.97-103,2005.

[8]. Maruyama T, "Statical Elastic Dislocations in an Infinite and Semi-infinite Medium", Bull. Earthquake Res. Inst., vol. 42, pp. 289-368, 1964.

[9]. Rani Sunita and Singh Sarva Jit," Static Deformation of Two Welded Half-spaces due to Dip-slipFaulting", Proc. Indian Acad. Sci.(Earth Planet. Sci.), vol. 101, pp.269-282, 1992.

[10]. Rongved L, "Force Interior to one of the two Joined Semi-infinite Solids", in Proc. Of the 2nd Midwestern Conf on Solid Mech.,ed, Bogdanoff J L Purdue University, Indiana, Res., Ser., vol.129, pp. 1-13, 1955.

[11]. Singh Mahabir and Singh Sarva Jit, "Static Deformation of a Uniform Half-space due to a very Long Tensile Fault", ISET J. Earthquake Techn. , vol. 37, pp. 27-38, 2000.

[12]. Singh Sarva Jit and Garg Net Ram, "On Two-dimensional Elastic Dislocations in a Multilayered Half-space", Phy. Earth Planet. Int., vol. 40, pp. 135-145,1985.

[13]. Singh Sarva Jit and Rani Sunita, " Static Deformation due to Two-dimensional Seismic Sources Embedded in an Isotropic Half-space in Welded Contact with an Orthotropic Half space", J. Phys. Earth, vol. 39, pp. 599-618, 1991.

[14]. Singh Sarva Jit, Kumar Anil, Rani Sunita and Singh Mahabir, " Deformation of a Uniform Half-space due to a Long Inclined Tensile Fault", Geophys. J. Int. , vol. 148,pp. 687-691, 2002.(see also Erratum; Geophys. J. Int., vol. 151, pp. 957(2002)).

[15]. Singh Sarva Jit, Rani Sunita and Garg Net Ram, " Displacements and Stresses in Two Welded Half-spaces Caused by Two Dimensional Sources", Phys. Earth Planet. Int., vol. 70, pp. 90-101,1992.

[16]. Sipkin S A, "Interpretation of Non-double- Couple Earthquake Mechanisms Derived from Moment Tensor Inversions", Journal of Geophysical Research, vol. 91, pp. 531-547, 1986.

[17]. Sokolnikoff I S, "Mathematical Theory of Elasticity", (Newyork: McGraw-Hill), 1956.

[18]. Yang X M and Davis P M, "Deformation due to a Rectangular Tensile Crack in an Elastic Half-space", Bulletin of Seismological Society of America, vol. 76, pp. 865-881, 1986.